Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Review of the Policy Implications	)	MM Docket No. 91-221
of the Changing Video Marketplace	)	

COMMENTS OF GENERAL INSTRUMENT CORPORATION

General Instrument Corporation ("GIC") is a leading supplier of equipment for the transmission, distribution, and access control of television signals for the broadband communications industry. GIC's Comm/Scope Division supplies more than half of the coaxial cable used by U.S. cable television industry. GIC's Jerrold Division has a major share of the addressable converter/descrambler market as well as a significant share of the cable television distribution electronics market, including both radio frequency and fiber optics technologies. GIC's VideoCipher Division is the leading supplier of encryption products for conditional access to satellite delivered television signals, both for the home satellite market and for the cable television market.

In June of 1990, GIC submitted to the FCC the first all digital proposal for terrestrial simulcast High Definition Television. Through its participation in the American TeleVision Alliance, General Instrument now plays an important technical role in the development of

two of the six proponent systems which will be tested by the Advanced Television Test Center as part of the FCC's process for selecting a High Definition Television standard for the United States. Both systems are all-digital, making extensive use of digital compression and transmission technologies to achieve the objectives of picture quality, coverage, and cost which the HDTV standard will require.

General Instrument welcomes this proceeding and is keenly interested, as an equipment supplier, in the Commission's analysis and recommendations. We wish to provide the Commission with information regarding our understanding of the key technologies in which we are active participants. It is not our purpose to comment on the Commission's policies relating to industry structural and regulatory issues.

Digital Compression Technology

DigiCipher™ digital compression technology is a central element of three separate but related development activities within General Instrument. DigiSat™ products apply digital compression and transmission to the satellite transmission of multiple channels of NTSC video on a single satellite transponder. DigiCable™ products use digital compression and transmission to transmit multiple NTSC signals in a 6 MHz cable television channel. DigiCipher™ HDTV utilizes the same technologies and techniques to compress and transmit a high definition television signal in a 6 Mhz terrestrial broadcast channel.

The multi-channel NTSC technologies are being used to develop products which will find

their way to market over the next 1 to 3 years. The HDTV activity is a technology development, as opposed to a product development, with the timing of HDTV products dependent on progress and results of the broadcast standardization process. A key technical philosophy has been to develop the digital NTSC products with an eye towards the introduction of digital HDTV, and efforts have been made to maintain the highest possible degree of commonality and compatibility both across media (e.g., cable, satellite, terrestrial broadcasting) and across formats (e.g., NTSC, HDTV).

Simply stated, digital compression and transmission afford three advantages compared to current analog technologies:

1. expanded channel capacity from compressing multiple NTSC signals or wider bandwidth HDTV into 6 MHz bandwidth
2. freedom from channel related transmission impairments and hence, improved picture quality, made possible by digital transmission, coupled with forward error correction and adaptive equalization (correction for multipath)
3. increased video/audio security from digital encryption of both video and audio.

These advantages of digital technology are not revolutionary. In the past several years, however, advances in microelectronics and miniaturization together with enhancements of signal processing techniques have made possible practical digital video compression and transmission technologies which can be embodied in cost effective products serving

a competitive marketplace.

Compression and HDTV

General Instrument has a long history of utilizing digital processing, digital transmission, and custom Very Large Scale Integrated circuits (VLSI) in its businesses. Stimulated by the Commission's proceeding on Advanced Television, a development program was initiated in 1987 to assure practical transmission of HDTV through cable and satellite, assuming that terrestrial HDTV standards would be adopted.

The proponent analog technologies under consideration at that time for terrestrial HDTV would have had compatibility problems with the installed base of satellite dishes. The required increase in carrier to noise ratio would have implied doubling the diameter of millions of home satellite dishes. In addition, tens of thousands of satellite dishes at television stations and cable television headends would also have been made obsolete. General Instrument chose to develop compression and transmission technology which would transmit HDTV through existing satellite links carrying NTSC. The ground rule was that there should be absolutely no increase in link budget to receive HDTV through any channel capable of transmitting NTSC. The chosen solution was all-digital.

In March 1990, the Commission asserted its preference for a simulcast HDTV standard (as opposed to an augmentation approach or an in-channel NTSC - compatible approach). The Commission also opened the door for improved technologies, such as all-digital, to

be presented for consideration in 1992. In June 1990, General Instrument submitted DigiCipher™ HDTV for consideration as the first all digital simulcast transmission standard. Since that submission, Zenith /AT&T have revised their hybrid approach and are now proposing an all-digital standard as is the Advanced Television Research Consortium. The only analog systems to be tested are the ATRC's ACTV, which is an EDTV system, not HDTV, and NHK's narrow MUSE. It is General Instrument's technical viewpoint that the technical superiority of digital HDTV will be clearly demonstrated by objective and subjective testing, and that the next generation broadcast standard will be digital.

Compression and Multiple Media

DigiCipher™ technology is a core television technology embodying all-digital solutions for compression, transmission, and access control. A natural outgrowth of the research on HDTV compression was the application of those advances to NTSC signals where non-standard formats are permissible, namely cable, satellite, and recorded media. With the addition of broadcast requirements mandated by the HDTV standard setting process, the core technology applies across multiple media, and care has been taken to assure convenient interfaces.

The number of signals which can be compressed and transmitted through a channel depends both on the nature of the channel and on the characteristics of the signal. DigiCipher™ compression is combined with quadrature phase shift keying (QPSK) for satellite transmission; quadrature amplitude modulation (QAM) is used for terrestrial

broadcast and cable television applications. Taking as baseline transmission conditions no increase in link budget and no increase in bandwidth, the raw data rate through a 24 MHz satellite transponder using QPSK is 40 MBPS; the raw data rate in a 6 MHz terrestrial or cable channel, using 32 QAM, is 24 MBPS.

The satellite channel can carry one or two HDTV signals or six to ten NTSC signals. For full motion video having a great deal of motion or detail, six signals per transponder can be transmitted with no visible impairments. Film-based material (like movies) can be compressed more than video, and ten signals can be transmitted without impairments.

The terrestrial channel, broadcast or cable, has roughly half the capacity of the satellite channel. Thus, one HDTV signal, or three to five NTSC signals, can be transmitted through a single 6 MHz channel, where the larger number of NTSC signals applies for film-based video programming.

It is beyond the scope of this comment to describe the detailed operation of General Instrument's digital technologies. However, at the SS/WP-1 certification meeting in Washington, D.C., lengthy disclosure was presented on the DigiCipher™ HDTV System, and that material is documented in FCC document TM62004.

DigiCipher™ compression is efficient, based on well-established principles of transform coding and motion compensation, and provides high quality pictures with low decoder

complexity. While General Instrument believes that it has developed excellent technology, it is important to note that there is a multiplicity of suppliers of some or all of the critical elements of a digitally compressed television system. Not only are there two other highly qualified proponents of digital HDTV (Zenith/AT&T and ATRC) but there are also numerous suppliers and potential suppliers of compression and transmission products for NTSC. It is our opinion that digital video compression is a practical and economic technology which will find numerous applications in the video marketplace.

Market Applications of Compression

The initial application of high quality video compression will probably be for satellite delivery of cable television programming. During the course of this year, General Instrument has conducted demonstrations of multi-channel satellite transmission using prototype equipment for encoding and decoding. Additionally, preliminary experiments have been conducted demonstrating the feasibility of digitally compressed multi-channel digital NTSC transmission over cable television. Product developments are underway for both cable and satellite, however, the economics of the satellite application are more conducive to early product introduction.

By mid-year 1992, General Instrument will make available commercial quantities of DigiSat™ encoders permitting satellite programmers to combine six or more signals on a single transponder. At the same time, integrated receiver/descramblers (IRDs) will be made available both for commercial use (at TV stations and cable headends) and for

private use (for home satellite dish owners). The home dish IRDs will be backwards compatible with existing VideoCipher™ descramblers, which, however, will not be forward compatible to DigiCipher™ transmissions. The situation will be completely analogous to the anticipated introduction of HDTV: the new receivers will be capable of receiving both the old format and the new one, but the new format will be incompatible with the old receivers.

The digital technologies are sufficiently advanced to permit pricing for the digital encoding and decoding equipment which will be competitive with analog satellite encoders and decoders. It is expected that costs will decrease with volume, following a typical "learning curve" for electronic equipment. Given the characteristics of the cable television equipment market, it will probably take two to three years experience before the cost of digital decompression converters will be attractive for widespread use in cable television systems.

However, it is expected that much of the learning experience, especially at the VLSI level, will be transferrable to HDTV, and that HDTV sets built in the 1994-1995 time frame (assuming a standards decision in 1993) will benefit from cost reductions due to the multi-channel NTSC production experience.

The roll-out of DigiSat™ multi-channel satellite transmission equipment will probably be gradual. The economics are compelling for new and incremental programming services

for which satellite transmission (as much as $2 million to $3 million) is a major fraction of operating expenses. Niche pay services, multi-channel pay-per-view services, multiplex pay services, and multiple time zone delivery, regional sports, and regional news are but a few of the services which are expected to benefit and the cost reduction brought or by digital compression on satellites.

However, the current satellite programmers for whom there is a significant commercial and consumer installed base are likely to adopt compression in a manner which will minimize disruption for current customers. Similar logic suggests gradual adoption of digital technology for cable television, where it is expected that digital and analog technologies will co-exist for the foreseeable future.

Conclusion

In summary, then, this comment attempts to inform the Commission of the state of development of digital compression products and technologies at General Instrument. It is our firm belief that a digital HDTV standard will be selected by the Commission, and that although digital NTSC products will reach the market first for satellite and second for cable, the NTSC experience will help drive down the cost of broadcast HDTV. Every effort is being made to facilitate forward and backward compatibility as new technologies are introduced, and great attention has been given to inter-media interfaces as well.

Over the next ten years, General Instrument expects that numerous technologies,

including fiber optics, interactivity, and digital compression, will greatly expand the possibilities for television programming. The deployment of these technologies rests in the hands of others; General Instrument eagerly awaits the comments of the creative community, the station and cable system owners, and the producers and distributors of programming, for those entities will fashion the video marketplace in which our technology will be deployed.

Respectfully submitted,

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